Contents – Compliance Options Diagrams

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Figure 1

Compliance Options under Subpart JJJJ

[Back to Top]

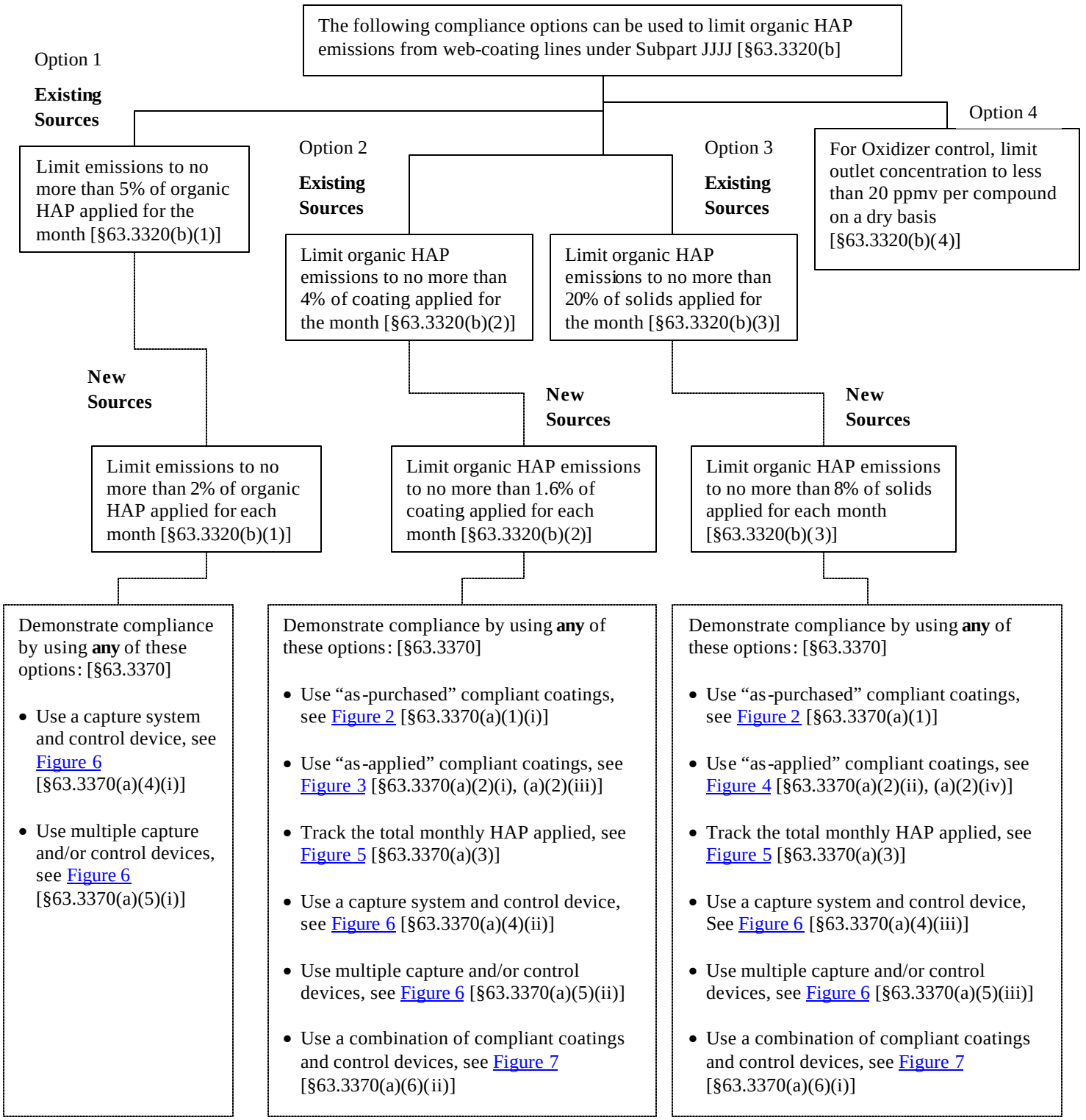

Figure 2

Demonstrate Compliance by Using "As-Purchased" Compliant Coatings (Option 2 or 3)

[Back to top] [See Figure 1]

If "**as-purchased**" compliant materials are used to demonstrate compliance with the emission limits in §63.3320(b)(2) or (3), you may use **any one** of the following sub-options to comply: [§63.3370(a)(1)]

Each coating material applied during the month doesn't exceed:

- 0.04 kg organic HAP/kg coating material (4% wt) "as-purchased" for **existing** sources
- 0.016 kg organic HAP/kg coating material (1.6% wt) "as-purchased" for **new** sources

or

Each coating material applied during the month doesn't exceed:

- 0.20 kg organic HAP/kg solids coating material (20 weight percent solids) "as-purchased" for **existing** sources
- 0.08 kg organic HAP/kg solids coating material (8.0 weight percent solids) "as-purchased" for **new** sources

- Determine the organic HAP weight-fraction of each coating material "as-purchased" [C_{hi}] by following §63.3360(c)(1)-(3)

- Determine the organic HAP weight-fraction of each coating material "as-purchased" [C_{hi}] by following §63.3360(c)(1)-(3) [See above]
- Determine the coating solids weight fraction [C_{si}] of each coating material "as-purchased" by following §63.3360(d)(1)-(2) [See box to right]
- Determine the "as-purchased" kg HAP/kg solids coating material [H_{si}] by using Equation 3 in §63.3370(b)(2)(ii)

§63.3360(c)(1)-(3) requires the o/o to determine the organic HAP weight-fraction "as purchased" [C_{hi}] by doing **any** of the following:

- Test the coating material using Method 311[1]
- Use Method 24 to determine the volatile organic content (weight-fraction of non aqueous volatile matter) of the coating material and use this value as a surrogate for the organic HAP content[2]
- Use formulation data to determine the organic HAP weight-fraction of the coating material[3]

[See Figure 3] [See Figure 4]

§63.3360(d)(1)-(2) requires the o/o to determine the solids content "as purchased" [C_{si}] by doing **any** of the following:

- Use Method 24 to determine the solids weight fraction of the coating material[2]
- Use formulation data to determine the solids weight fraction of the coating material[4]

[See Figure 4] [See Figure 5]

[1]Follow §63.3360(c)(1)(i)-(iii) to determine the organic HAP mass fraction. The manufacturer may perform Method 311 determination.
[2]Follow §63.3360(d)(1) to determine volatile organic and solids content. The manufacturer may perform Method 24 determination.
[3]Formulation data must represent all organic HAP present at levels = 0.1% for carcinogens and =1.0% for non-carcinogens in any raw material used, weighted by the mass fraction of each raw material used. The manufacturer may provide formulation data. In the event there is any inconsistency between Method 311 and formulation data, the results of Method 311 will govern.
[4]In the event there is any inconsistency between Method 24 and formulation data, the results of Method 24 will govern.

Figure 3
Demonstrate Compliance by Using "As-Applied" Compliant Coatings (Option 2)

[Back to top] [See Figure 1]

If "as-applied" compliant coating materials is used to demonstrate compliance with the emission limits in §63.3320(b)(2), you may use any one of the following sub-options to comply: [§63.3370(a)(2)]

2 options

Each coating material as-applied doesn't exceed: [§63.3370(a)(2)(i)]

- 0.04 kg organic HAP/kg coating material (4% wt) "as-applied" for **existing** sources
- 0.016 kg organic HAP/kg coating material (1.6% wt) "as-applied" for **new** sources

Calculate organic HAP content of materials "as-applied", accounting for materials that are added to the coating prior to application [§63.3370(c)(1)]

- Determine the "as purchased" organic HAP content or volatile organic content of **each** coating material applied by following §63.3360(c) [see box to the right] [§63.3370(c)(1)(i)]

AND

- Determine **any one** of the following: [§63.3370(c)(1)(ii)]
  - Calculate the "as-applied" organic HAP content of each coating material [C_{ahi}] by using Equation 1a[1] in §63.3370(b)(1)(ii)
  - Calculate the "as-applied" volatile organic content of each coating material [C_{avi}] by using Equation 1b[2] in §63.3370(b)(1)(ii)

[See Figure 7] [See Figure 10] [See Figure 11] [See Figure 12] [See Figure 13]

§63.3360(c) requires you to do the following:

- Determine the organic HAP weight-fraction of each coating material "as-purchased" [C_{hi}] by following §63.3360(c)(1)-(3)

or

Monthly average of all coating materials used doesn't exceed: [§63.3370(a)(2)(iii)]

• 0.04 kg organic HAP/kg coating material (4% wt) for **existing** sources

• 0.016 kg organic HAP/kg coating material (1.6% wt) for **new** sources

- Determine the organic HAP weight fraction of each coating material "as-purchased" [C_{hi}] by following §63.3360(c)(1)-(3)
- Determine the monthly average organic HAP content of all materials applied [H_L] by using Equation 4 in §63.3370(c)(3)

[1]If solvent or other materials are not added to the as-purchased coating material, then the as-applied organic HAP mass fraction is equal to the as-purchased organic HAP mass fraction.
[2]Follow this method if you choose to use the volatile organic mass fraction as a surrogate for the organic HAP mass fraction of coatings.

Figure 4
Demonstrate Compliance by Using "As-Applied" Compliant Coatings (Option 3)

[Back to top] [See Figure 1]

If "as-applied" compliant coating materials is used to demonstrate compliance with the emission limits in §63.3320(b)(3), you may use any one of the following sub-options to comply: [§63.3370(a)(2)]

2 options

Each coating material as-applied doesn't exceed: [§63.3370(a)(2)(ii)]

• 0.2 kg organic HAP/kg coating solids "as-applied" for **existing** sources

• 0.08 kg organic HAP/kg coating solids "as-applied" for **new** sources

or

Monthly average of all coating materials used doesn't exceed: [§63.3370(a)(2)(iv)]

• 0.2 kg organic HAP/kg coating solid for **existing** sources

• 0.08 kg organic HAP/kg coating solids for **new** sources

Perform **all** of the following:

- Determine the organic HAP weight-fraction of each coating material "as-purchased" [C_{hi}] by following §63.3360(c)(1)-(3)
- Determine the organic HAP weight-fraction of each coating material "as-applied" [Cahi] by following §63.3370(c)(1)(ii)
- Determine the solids content of each "as-purchased" coating material by following §63.3360(d)(1)-(2) [§63.3370(c)(2)(i)]
- Calculate the solids content of "as-applied" materials [C_{asi}]by using Equation 2 in §63.3370(c)(2)(i)
- Calculate the "as-applied" organic HAP to solids ratio [H_{asi}] by using Equation 3 in §63.3370(c)(2)(ii) [1]

[See Figure 7] [See Figure 10] [See Figure 11] [See Figure 12] [See Figure 13]

- Determine the organic HAP mass fraction of each coating material "as-purchased" by following §63.3360(c)(1)-(3)
- Determine the coating solids content [C_{si}] of each "as-purchased coating material by following §63.3360(d)(1)-(2)
- Determine the monthly average organic HAP/kg coating solids of all materials applied [H_S] by using Equation 5 in §63.3370(c)(4)

[1]If solvent or other materials are not added to the "as-purchased" coating materials, then the "as-applied" kg organic HAP/kg coating solids is equal to the "as-purchased" kg organic HAP/kg coating solids.

Figure 5
Demonstrate Compliance by Tracking the Total Monthly HAP Applied

[Back to top] [See Figure 1]

If monthly allowable organic HAP applied is used to demonstrate compliance with the emission limits in §63.3320(b)(2) and (3), you may use the following option to comply: [§63.3370(a)(3)]

Demonstrate that the total monthly organic HAP applied is less than the calculated equivalent allowable organic HAP

Demonstrate that the total monthly organic HAP applied (H_m) is less than the calculated allowable organic HAP (H_a) by doing all of the following: [§63.3370(d)]

- Determine the total monthly organic HAP applied [H_m] by using Equation 6 in §63.3370(d)
- Determine the values needed to calculate the monthly allowable organic HAP limit [H_a] by following §63.3370(l) [See box to the right] and then
- Calculate H_a based on the following (use Equation 13a for **existing** sources and Equation 13b for **new** sources):
  - Materials applied containing = 20 mass percent coating solids complying with the kg HAP/kg solids coating limit, and
  - Materials applied containing < 20 mass percent coating solids complying with the kg HAP/kg coating limit

[See Figure 7] [See Figure 10] [See Figure 11] [See Figure 12] [See Figure 13]

§63.3370(l) requires the o/o to do all of the following:

- Determine the mass of each coating applied on an as-purchased basis
- Determine the "as-purchased" coating solids content of each coating material applied in accordance with §63.3360(d)(1)-(2)
- Determine the as-purchased mass fraction of each coating material applied at greater than or equal to 20 mass percent coating solids content.
- Determine the total mass of each solvent, diluent, thinner, or reducer added to the coating materials which were applied at less than 20 mass percent coating solids content.

Figure 6
Demonstrate Compliance by Using a Control Device (Option 1)

[Back to top] [See Figure 1]

If a **control device** is used to demonstrate compliance with the emission limits in §63.3320(b)(1), then: [§63.3370(a)(4)(i)]

Operate a capture system and control device that meets a monthly overall organic HAP control efficiency of at least [§63.3370(e)]

- 95% for **existing** sources
- 98% for **new** sources

Determine the overall organic HAP control efficiency by doing **one** of the following: [§63.3370(e)]

- For solvent recovery devices, follow the procedures in §63.3370(i), See Figure 9
- For Oxidizer systems, follow the procedures in §663.3370(k), See Figure 12

If the affected source:

- Only operates **always-controlled work stations** with **more than one capture system or more than one control device**, then demonstrate compliance using one of the following: [§63.3370(e)(1)]
  - Follow the procedures in §63.3370(n), See Figure 12

  OR
  - Follow the procedures in §63.3370(p) [See box to the right]
- Operates one or more **never-controlled work stations** or one or more **intermittently-controlled work stations**, then follow the procedures in §63.3370(n), see Figure 13 [§63.3370(e)(2)]

§63.3370(p) requires one of the following to demonstrate compliance on a monthly basis for each web coating line or group of coating lines controlled by a common control device:

- Demonstrate the volatile organic matter collection and recovery efficiency [Rv] is at least 95% at existing sources or 98% at new sources. Calculate Rv by following §63.3370(i)(1) (*i*), (iii), (v), and (vi) [§63.3370(p)(1)]
  - Measure the mass of each coating applied; determine the volatile organic content [Cavi] of each coating material applied; monitor the volatile organic matter recovered according to §63.3350(d); and calculate volatile organic matter collection and recovery efficiency [Rv]. See Equation 7

  OR
- Demonstrate the overall organic HAP control efficiency for each coating line or group of coating lines served by a common capture system is at least 95% at existing sources or 98% at new sources. Demonstrate compliance by doing one of the following: [§63.3370(p)(2) or (3)]
  - Follow the procedures in §63.3370(i)(2)(i)-(iv) –
    - ❖ Continuously monitor the control device inlet and outlet gas stream such that the control device efficiency can by calculated using Equations 1 and 2 of §63.3360; continuously monitor operating parameters established to ensure capture efficiency; determine the percent capture efficiency according to §63.3360(f); and calculate the overall organic HAP control efficiency [R] using Equation 11
  - Follow procedures in §63.3370(k)(1)(i)-(iii) and (k)(2)(i) –
    - ❖ Determine the oxidizer destruction efficiency [E]; determine the capture system efficiency [CE]; monitor the capture and control efficiency; and calculate the overall organic HAP control efficiency [R] using Equation 11

Figure 7
Demonstrate Compliance by Using A Combination of Compliant Coatings and Control Devices (Option 2 Or 3)

[Back to top] [See Figure 1]

If a combination of compliant coatings and control devices is used to demonstrate compliance with §63.3320(b)(2) or (3), you may use any one of the following options: [§63.3370(a)(6)]

Method 1

Demonstrate that the average equivalent emission rate doesn't exceed the following on a monthly basis: [§63.3370(a)(6)(i), §63.3370(f)]

- 0.2 kg organic HAP/kg solids material "as-applied" for existing sources
- 0.08 kg organic HAP/kg solids material "as-applied" for new sources

Method 2

Demonstrate that the average equivalent emission rate doesn't exceed the following on a monthly basis: [§63.3370(a)(6)(ii), §63.3370(g)]

- 0.04 kg organic HAP/kg coating material "as-applied" for existing sources
- 0.016 kg organic HAP/kg coating material "as-applied" for new sources

Method 3

Demonstrate that the average equivalent emission rate doesn't exceed the allowable calculated limit [§63.3370(a)(6)(iii), §63.3370(h)]

- Calculate the monthly allowable HAP emissions limit [Ha] by following §63.3370(l) See Figure 5

Then determine one of the following:

- HAP emission rate based on amount of coating material applied (kg HAP/kg coating). See Figure 3
- HAP emission rate based on coating solids applied (kg HAP/kg solids). See Figure 4
- HAP emissions less than calculated allowable. See Figure 5

- Follow procedures in §63.3370(i) if a solvent recovery device is used, see Figure 9
- Follow procedure in §63.3370(k) if an oxidizer is used, see Figure 12

Unless your affected source:

Operates more than one capture system, more than one control device, one or more never-controlled work stations, or one or more intermittently-controlled work stations, then follow the procedures in §63.3370(n), see Figure 13

Figure 8
Demonstrate Compliance by Using a Capture and Control System to Meet the Outlet Concentration Limit (Option 4)
[Back to Top] [See Figure 1]

If an oxidizer is used to demonstrate compliance with §63.3320(b)(4) and you choose to meet the outlet organic HAP concentration limit, you must use the following option: [§63.3370(a)(4)(i)]

Demonstrate that the organic HAP concentration at the outlet of the oxidizer is no greater than 20 ppmv by compound an a dry basis [§63.3370(a)(4)(i)]

§63.3370(e)(3) requires a facility to install a Permanent Total Enclosure (PTE) around the coating line and to do the following:

- Demonstrate that a PTE is installed and meets the requirements in §63.3360(f)(1)

AND

- Determine the organic HAP concentration at the outlet of the PTE using one of the following:
  - Determine the control device efficiency using Equations 1 and 2 of §63.3360 and the applicable test methods and procedures specified in §63.3360(e)
  - Use a CEMS to determine the organic HAP emission rate according to paragraphs §63.3370(i)(2)(i) through (i)(2)(x)

Figure 9
Requirements for Solvent Recovery Devices

[Back to top] [See Figure 6] [See Figure 7]

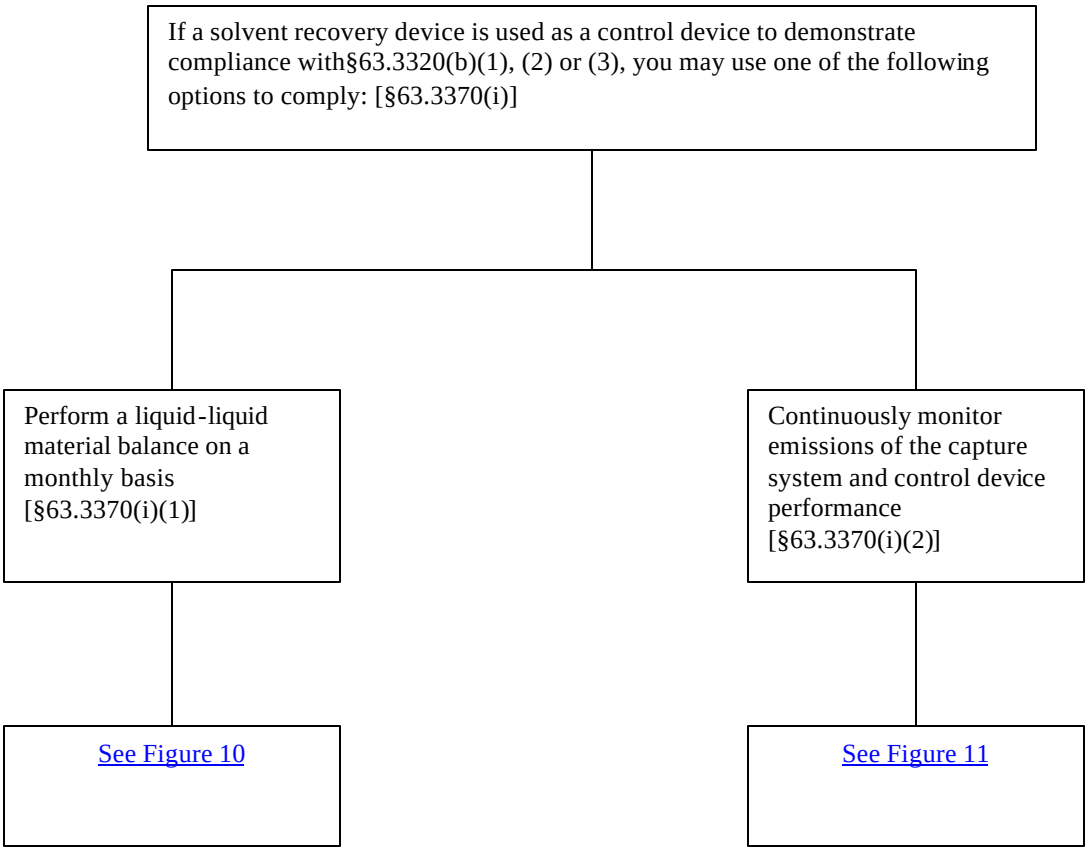

Figure 10
Liquid-Liquid Material Balance for Solvent Recovery Devices

[Back to top] [See Figure 9][Back to Figure 13]

If **liquid-liquid material** balance is used to demonstrate compliance of your **solvent recovery control device**, you must do all of the following: [§63.3370(i)(1)]

- Measure the mass of each coating material applied on the coating line or group of coating lines that are controlled during the month [§63.3370(i)(1)(i)]
- Determine the volatile organic content [C_{avi}] of each coating material "as-applied" during the month by following §63.3360(d) [See Fig 3] [§63.3370(i)(1)(iii)]
- Measure and monitor the amount of volatile organic matter recovered for the month by following §63.3350(d)(2) [see box to the right] [§63.3370(i)(1)(v)]
- Calculate the volatile organic matter collection and recover efficiency using Equation 7
- Calculate the organic HAP emitted during the month using Equation 8

§63.3350(d)(2) requires you to do all of the following:

- Install, calibrate, maintain, and operate according to the manufacturer's specifications a device that indicates the cumulative amount of volatile mater recovered by the solvent recovery device on a monthly basis
- Certify (through the manufacturer) that the device is accurate to within ±2.0% by mass

- **If** you're demonstrating compliance with **any** of the following, then determine the **organic HAP content** of each coating material "as-applied' [C_{ahi}] during the month by following §63.3360(c) [See Figure 3], then calculate the organic HAP emission rate based on coating material applied using Equation 10: [§63.3370(i)(1)(ii)]
  - The organic HAP emission rate based on solids applied
  - The organic HAP emission rate based on material applied
  - Emissions less than the calculated allowable organic HAP
- If you're demonstrating compliance with any of the following, then determine the solids content of each coating material applied during the month by following §63.3360(d) [See Figure 4], then calculate the organic HAP emission rate based on coating solids applied using Equation 9: [§63.3370(i)(1)(iv)]
  - The organic HAP emission rate based on solids applied
  - Emissions less than the calculated allowable organic HAP
- If you're demonstrating compliance by limiting emissions to less than the allowable, determine the monthly allowable organic HAP emissions following §63.3370(l). [See Figure 5]

Figure 11
Continuous Emission Monitoring for Solvent Recovery Devices

[Back to top] [See Figure 9]

If a solvent recovery device is used as your control device and you demonstrate compliance with the use of a Continuous Emission Monitoring (CEM) device, you must do the following: [§63.3370(i)(2)]

- Demonstrate initial compliance by conducting a performance test on capture efficiency [§63.3360]
- Install Continuous Emission Monitors (CEMs)
- Continuously monitor capture system operating parameters by following §63.3370(i)(2)(i)-(vii)

§63.3370(i)(2) requires all of the following: [§63.3370(i)(2)(i)-(iv)]

- Continuously monitor the gas stream entering and exiting the control device to determine the total organic volatile matter mass flow rate [§63.3370(i)(2)(i)]
- Calculate the percent control efficiency [E] of the control device each month by using Equation 2 in §63.3360(e)(1)(ix) [§63.3370(i)(2)(i)]
- Determine the percent capture efficiency [CE] by complying with §63.3360(f) [§63.3370(i)(2)(iii)]
- Calculate the overall organic HAP control efficiency [R] each month using Equation 11 in §63.3370(i)(2)(iv)
- Calculate the organic HAP emitted during the month using Equation 12, in §63.3370(i)(2)(viii)

AND, do the following, if applicable

- **If** you're demonstrating compliance with **any** of the following, then determine the **organic HAP content** of each coating material "as-applied' [C_{ahi}] during the month by following §63.3360(c) [See Figure 3], then calculate the organic HAP emission rate based on coating material applied using Equation 10: [§63.3370(i)(2)(vi)]
  - The organic HAP emission rate based on solids applied
  - The organic HAP emission rate based on material applied
  - Emissions less than the calculated allowable organic HAP
- **If** you're demonstrating compliance with **any** of the following, then determine the solids content of each coating material applied during the month by following §63.3360(d) [See Figure 4], then calculate the organic HAP emission rate based on coating solids applied using Equation 9: [§63.3370(i)(2)(vii)]
  - The organic HAP emission rate based on solids applied
  - Emissions less than the calculated allowable organic HAP
- **If** you're demonstrating compliance by limiting emissions to less than the allowable, determine the monthly allowable organic HAP emissions following §63.3370(l). [See Figure 5]

[See Figure 7] [See Figure 13]

Figure 12
Requirements for Oxidizers

[Back to top] [See Figure 6] [See Figure 7]

If an oxidizer is used as your control device, you must do the following [§63.3370(k)(1)]

- Demonstrate initial compliance by conducting a performance test on capture and control device efficiency [§63.3360(e) and (f)]
- Continuously monitor capture and control device operating parameters by following §63.3370(k)(1)(i)-(vi) [see box to the right]

§63.3370(k)(1) requires all of the following:

- Determine the oxidizer destruction efficiency [E] by complying with §63.3360(e) [§63.3370(k)(1)(i)]
- Determine the percent capture efficiency [CE] by complying with §63.3370(f) [§63.3370(k)(1)(ii)]
- Continuously monitor the operating parameter established in §63.3350(e) and (f) to ensure capture efficiency [§63.3370(k)(1)(iii)]
- Calculate the overall organic HAP control efficiency [R] each month using Equation 11 in §63.3370(i)(2)(iv)

AND, do the following, if applicable

- **If** you're demonstrating compliance with **any** of the following, then determine the **organic HAP content** of each coating material "as-applied' [C_{ahi}] during the month by following §63.3360(c) [See Figure 3]: [§63.3370(k)(1)(v)]
  - The organic HAP emission rate based on solids applied
  - The organic HAP emission rate based on material applied
  - Emissions less than the calculated allowable organic HAP
- **If** you're demonstrating compliance with **any** of the following, then determine the **solids content of each coating material** "as-applied" during the month by following §63.3360(d) [See Figure 4]: [§63.3370(k)(1)(vi)]
  - The organic HAP emission rate based on solids applied
  - Emissions less than the calculated allowable organic HAP
- **If** you're demonstrating compliance by limiting emissions to less than the allowable, determine the monthly allowable organic HAP emissions following §63.3370(l). [See Figure 5]

[See Figure 7] [See Figure 13]

Figure 13
Requirements for Multiple Control Devices and Never-Controlled or Intermittently-Controlled Work Stations

[Back to top] [See Figure 6] [See Figure 7]

If more than one capture system, more than one control device, one or more never-controlled work stations, and/or one or more intermittently-controlled work stations are used, than one of the following options can be chosen to comply: [§63.3370(n)]

Use a solvent recovery system and perform liquid-liquid material balance [§63.3370(n)(1)]
See Figure 10

Use a solvent recovery system and using performance testing with CEMs [§63.3370(n)(2)]
See Figure 11

Use an Oxidizer [§63.3370(n)(3)]
See Figure 12

Use uncontrolled coating lines [§63.3370(n)(4)]

- Determine the organic HAP applied using Equation 6. This is equal to the organic HAP emitted

Then determine one of the following:

- HAP emission rate based on amount of coating material applied (kg HAP/kg coating). See Figure 3
- HAP emission rate based on coating solids applied (kg HAP/kg solids). See Figure 4
- HAP emissions less than calculated allowable. See Figure 5

- Determine the mass of all coating materials "as-applied" in intermittently –controlled work stations operating in by-pass mode and the mass of all coating "as-applied" on never-controlled work stations during the month.
- Determine the mass of all coatings "as-applied" on intermittently-controlled work stations operating in a controlled mode and the mass of all coatings "as-applied" on always-controlled work stations during the

Solvent recovery using liquid-liquid material balance

- Calculate the organic HAP emitted during the month using Equation 14

Then determine one of the following:

- HAP emission rate based on amount of coating material applied (kg HAP/kg coating)
- HAP emission rate based on coating solids applied (kg HAP/kg solids)
- HAP emissions less than calculated allowable

Solvent recovery using CEM's or Oxidizer

- Calculate the organic HAP emitted during the month using Equation 15

Then determine one of the following:

- HAP emission rate based on amount of coating material applied (kg HAP/kg coating). See Figure 3
- HAP emission rate based on coating solids applied (kg HAP/kg solids). See Figure 4
- HAP emissions less than calculated allowable. See Figure 5

Figure 14
List of Equations

[Back to top]

Equation 1a – C_{ahi} = $$\frac{\left(C_{hi}M_i + \sum_{j=1}^{q} C_{hij}M_{ij}\right)}{M_i + \sum_{j=1}^{q} M_{ij}}$$ [See Figure 3]

Equation 1b – C_{avi} = $$\frac{\left(C_{vi}M_i + \sum_{j=1}^{q} C_{vij}M_{ij}\right)}{M_i + \sum_{j=1}^{q} M_{ij}}$$ [See Figure 3]

Equation 2 – C_{asi} = $$\frac{\left(C_{si}M_i + \sum_{j=1}^{q} C_{sij}M_{ij}\right)}{M_i + \sum_{j=1}^{q} M_{ij}}$$ [See Figure 4]

Equation 3 – H_{si} = $$\frac{C_{ahi}}{C_{asi}}$$ [See Figure 2] [See Figure 4]

Equation 4 – H_L = $$\frac{\left(\sum_{i=1}^{p} C_{hi}M_i + \sum_{j=1}^{q} C_{hij}M_{ij} - M_{vret}\right)}{\left(\sum_{i=1}^{p} M_i + \sum_{j=1}^{q} M_{ij}\right)}$$ [See Figure 3]

Equation 5 – H_S = $$\frac{\left(\sum_{i=1}^{p} C_{hi}M_i + \sum_{j=1}^{q} C_{hij}M_{ij} - M_{vret}\right)}{\left(\sum_{i=1}^{p} C_{si}M_i + \sum_{j=1}^{q} C_{sij}M_{ij}\right)}$$ [See Figure 4]

Equation 6 – H_m = $$\sum_{i=1}^{p} C_{hi}M_i + \sum_{j=1}^{q} C_{hij}M_{ij} - M_{vret}$$ [See Figure 5] [See Figure 13]

Equation 7 – R_V = $$\frac{M_{vr} + M_{vret}}{\left(\sum_{i=1}^{p} C_{vi}M_i + \sum_{j=1}^{q} C_{vij}M_{ij}\right)} \times 100$$ [See Figure 10]

Figure 14 (continued)
List of Equations

Equation 8 – H_e = $$\left[1-\frac{R_v}{100}\right]\left[\sum_{i=1}^{p} C_{hi}M_i+\sum_{j=1}^{q} C_{hij}M_{ij}-M_{vret}\right]$$ [See Figure 10]

Equation 9 – L = $$\frac{H_e}{\left(\sum_{i=1}^{p} C_{si}M_i+\sum_{j=1}^{q} C_{sij}M_{ij}\right)}$$ [See Figure 10]

Equation 10 – S = $$\frac{H_e}{\left(\sum_{i=1}^{p} M_i+\sum_{j=1}^{q} M_{ij}\right)}$$ [See Figure 10]

Equation 11 – R = $$\frac{(E)(CE)}{100}$$ [See Figure 6] [See Figure 11]

Equation 12 – H_e = $$(1-R)\left(\sum_{i=1}^{p} C_{ahi}M_i\right)-M_{vret}$$ [See Figure 11]

Equation 13a – H_a = $$0.20\left[\sum_{i=1}^{p} M_iG_iC_{si}\right]+0.04\left[\sum_{i=1}^{p} M_i(1-G_i)+\sum_{j=1}^{q} M_{Lj}\right]$$ [See Figure 5]

Equation 13b – H_a = $$0.08\left[\sum_{i=1}^{p} M_iG_iC_{si}\right]+0.016\left[\sum_{i=1}^{p} M_i(1-G_i)+\sum_{j=1}^{q} M_{Lj}\right]$$ [See Figure 5]

Equation 14 – H_e = $$\left[\sum_{i=1}^{p} M_{Ci}C_{ahi}\right]\left[1-\frac{Rv}{100}\right]+\left[\sum_{i=1}^{p} M_{Bi}C_{ahi}\right]-M_{vret}$$ [See Figure 13]

Equation 15 – H_e = $$\left[\sum_{i=1}^{p} M_{Ci}C_{ahi}\right]\left[1-\frac{R}{100}\right]+\left[\sum_{i=1}^{p} M_{Bi}C_{ahi}\right]-M_{vret}$$ [See Figure 13]